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## International Journal of Disaster Risk Reduction

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# Integration of census data based vulnerability in landslide risk mapping - The case of Angra dos Reis, Rio de Janeiro, Brazil

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**SER-457 - População, Espaço e Ambiente**

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## Mapa de Risco de Deslizamento de Terra

Área de risco: passível de ser atingida por fenômenos/processos naturais/induzidos que causem efeito adverso.

As pessoas que habitam essas áreas estão sujeitas a danos à integridade física, perdas materiais e patrimoniais.

(MAPEAMENTO..., 2007)

Requer uma abordagem interdisciplinar entre os sistemas humanos e naturais. Não só ações estruturais são necessárias, mas também a redução da vulnerabilidade não estrutural.

Desafios:

- Diferenças dentro das populações locais.
- Construção de índices.
- Limitações na obtenção de dados.



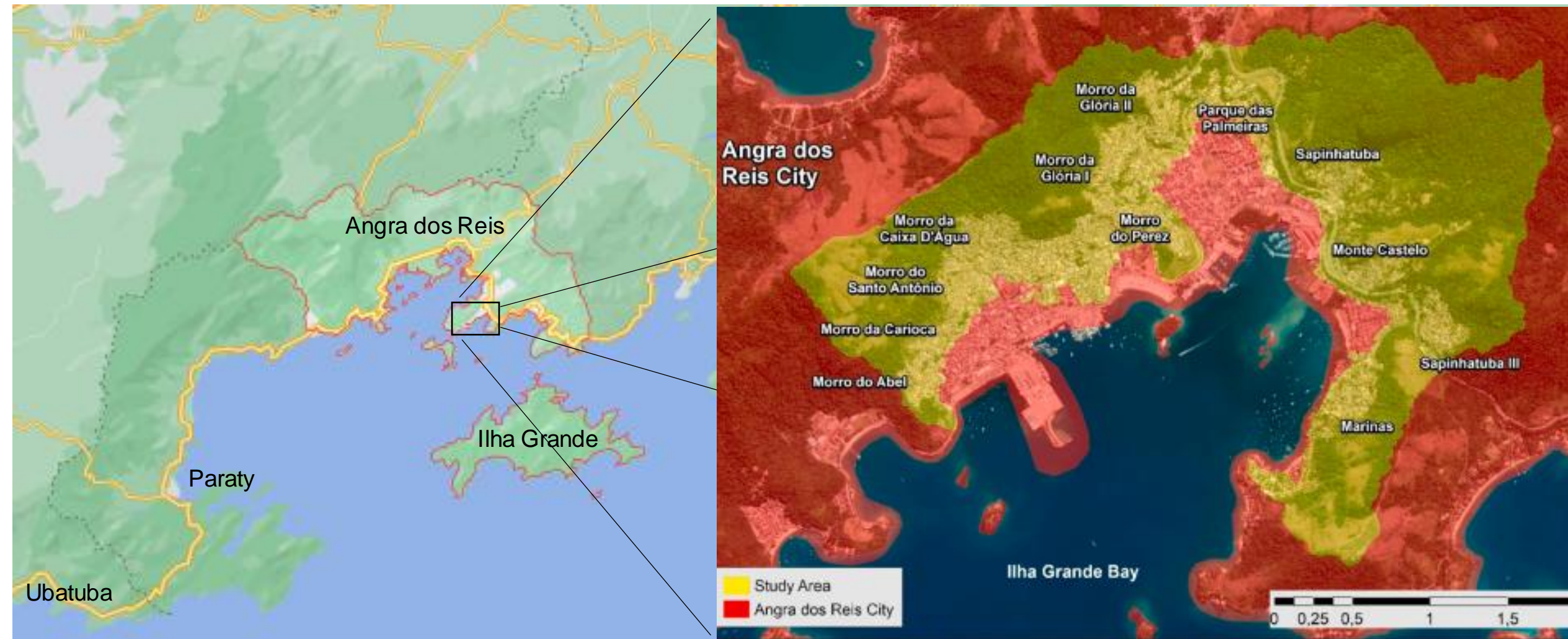
## Contribuição do Artigo

Contribuir para a gestão do risco de escorregamento, propondo um método para combinar dados de perigo, exposição e vulnerabilidade - os dois últimos baseados em informações censitárias.



## Contribuição do Artigo

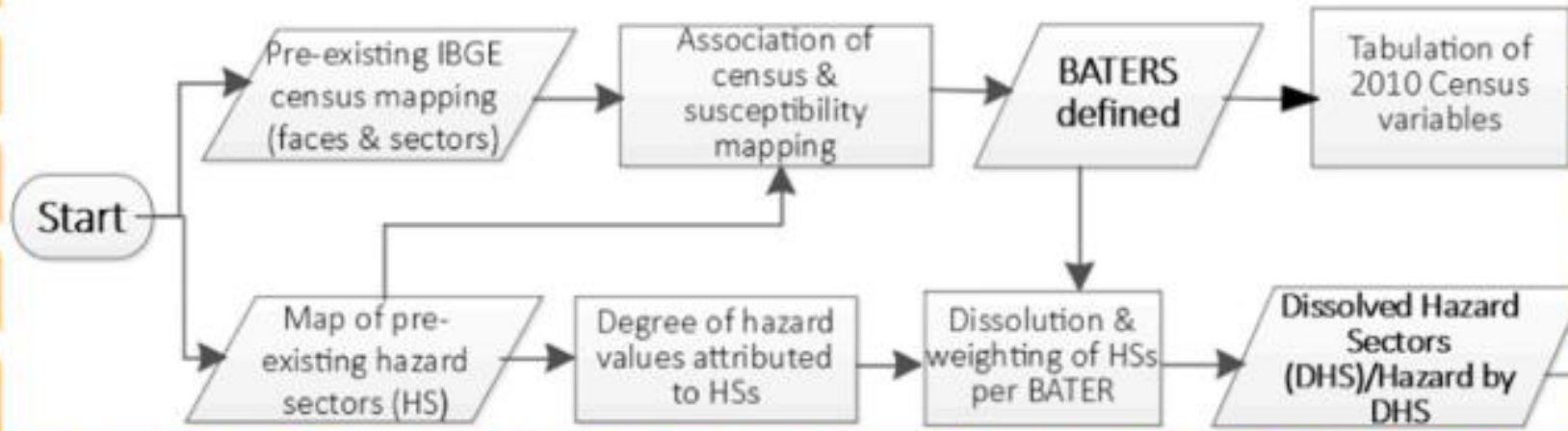
Contribuir para a gestão do risco de escorregamento, propondo um método para combinar dados de perigo, exposição e vulnerabilidade - os dois últimos baseados em informações censitárias.



# Estrutura Metodológica

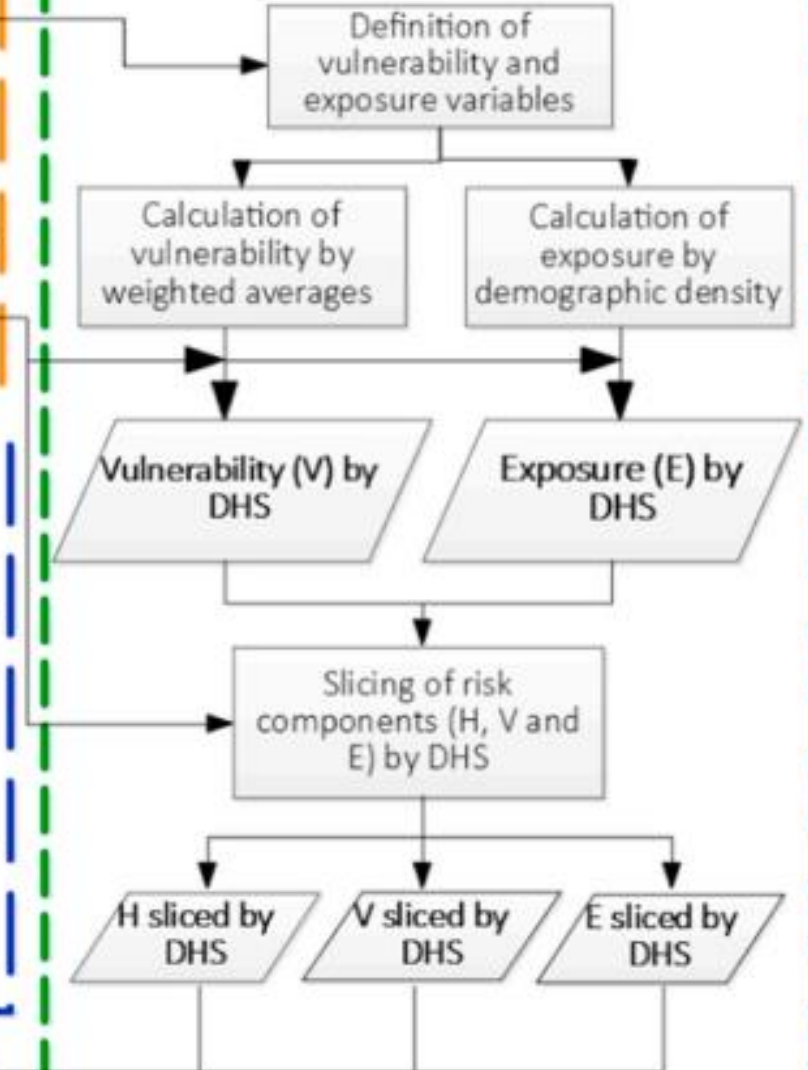
## FASE 1

### Compatibilization of hazard sectors and census tracts

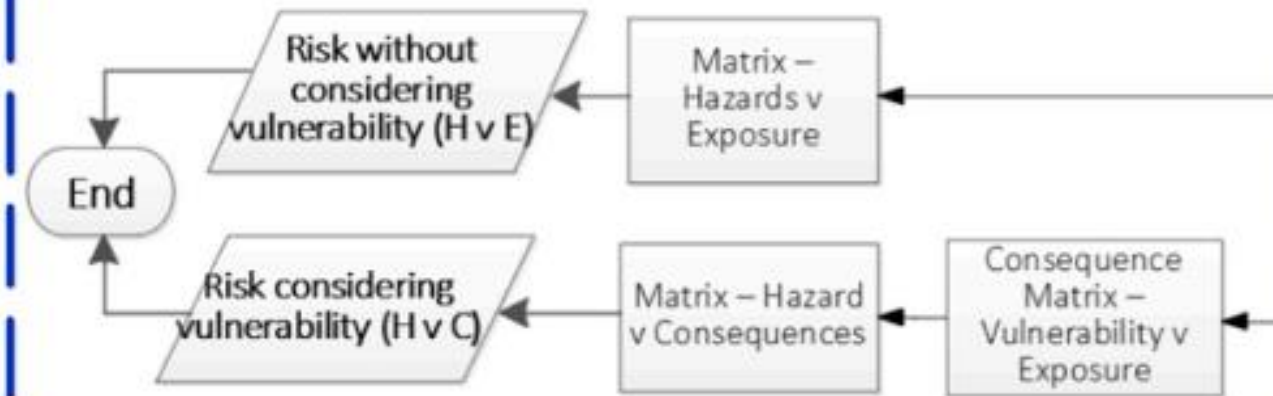


## FASE 2

### Calculation and mapping of vulnerability & exposure indicators and slicing risk components



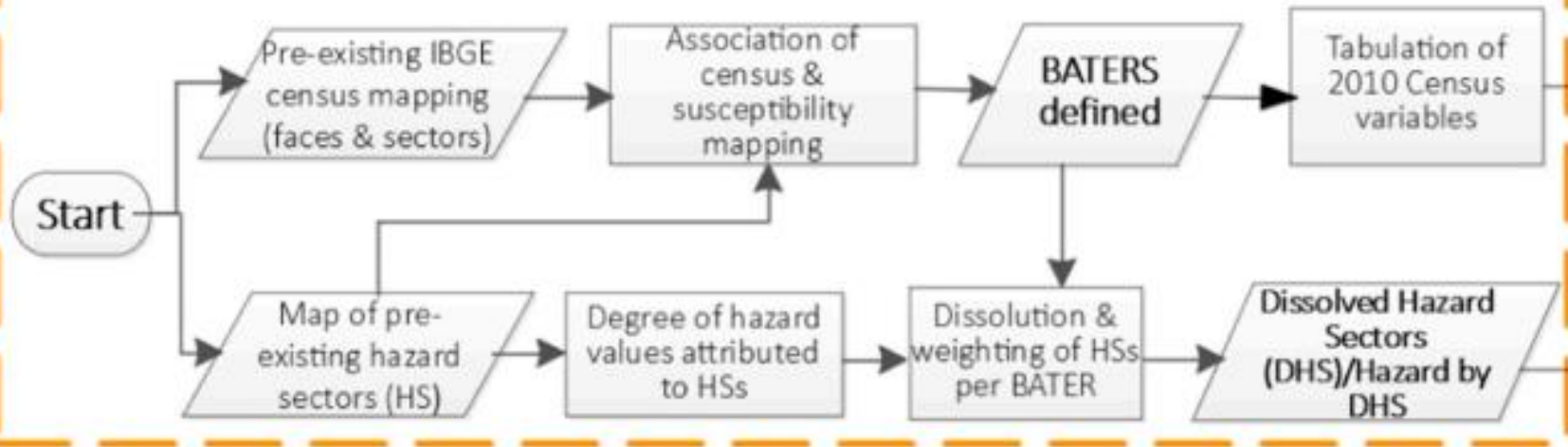
### Formulation of matrices and risk maps



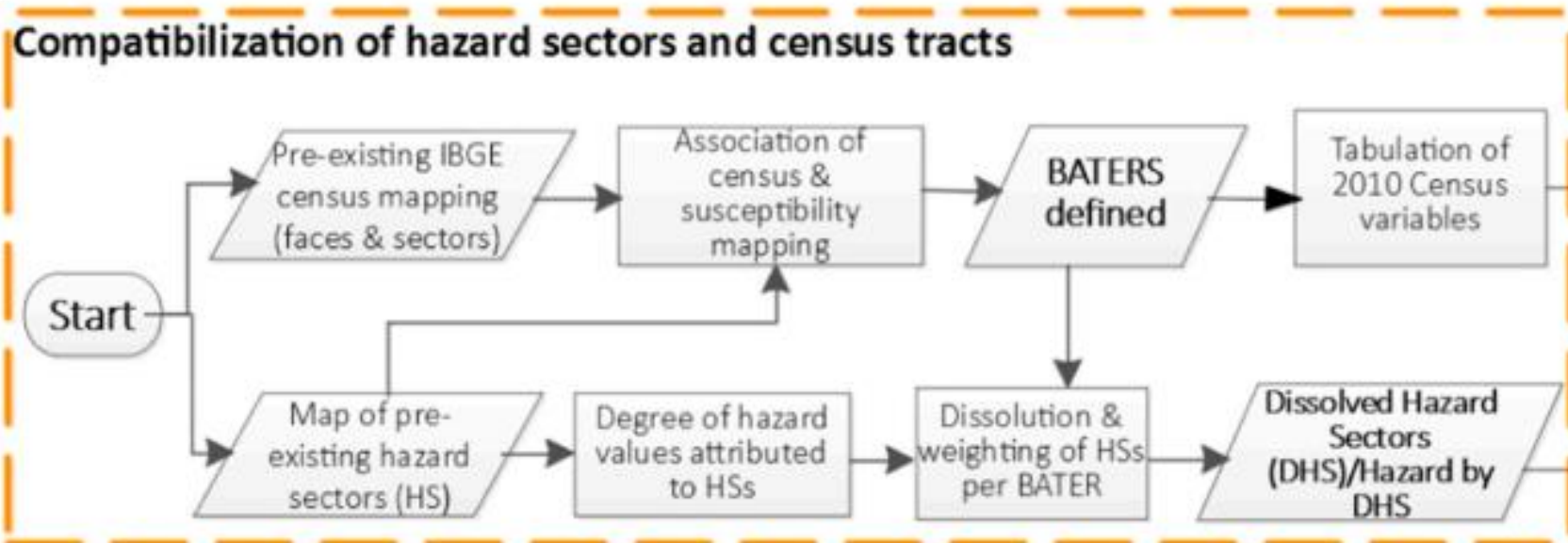
## FASE 3

# FASE 1

## Compatibilization of hazard sectors and census tracts



# BATER - Base Territorial Estatística de Áreas de Risco

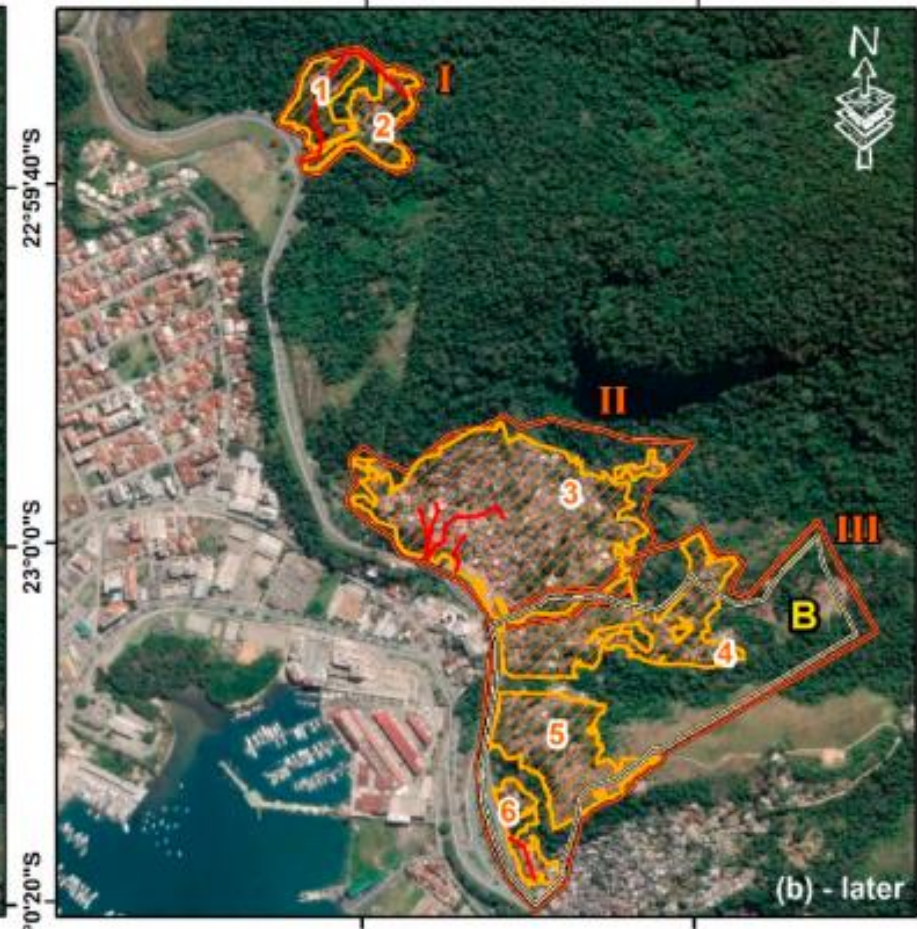
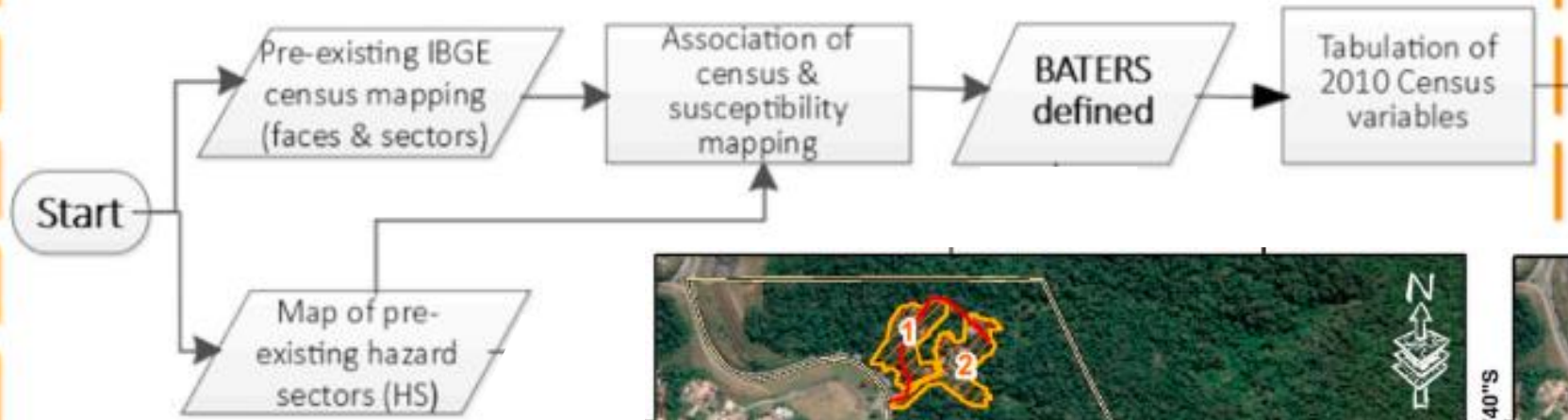


- IBGE + CEMADEN. Início em 2011, conclusão 2018.
- Recorte territorial visando compatibilizar dados censitários às áreas de risco.
- Interpretação visual, considerando o contexto espacial das áreas de risco e dos limites censitários.
- Prioritariamente a menor área possível.
- Mínimo 5 residências e 20 moradores.

(Asis Dias et al., 2018; Assis Dias et al., 2019; Saito et al., 2019)

# BATER - Base Territorial Estatística de Áreas de Risco

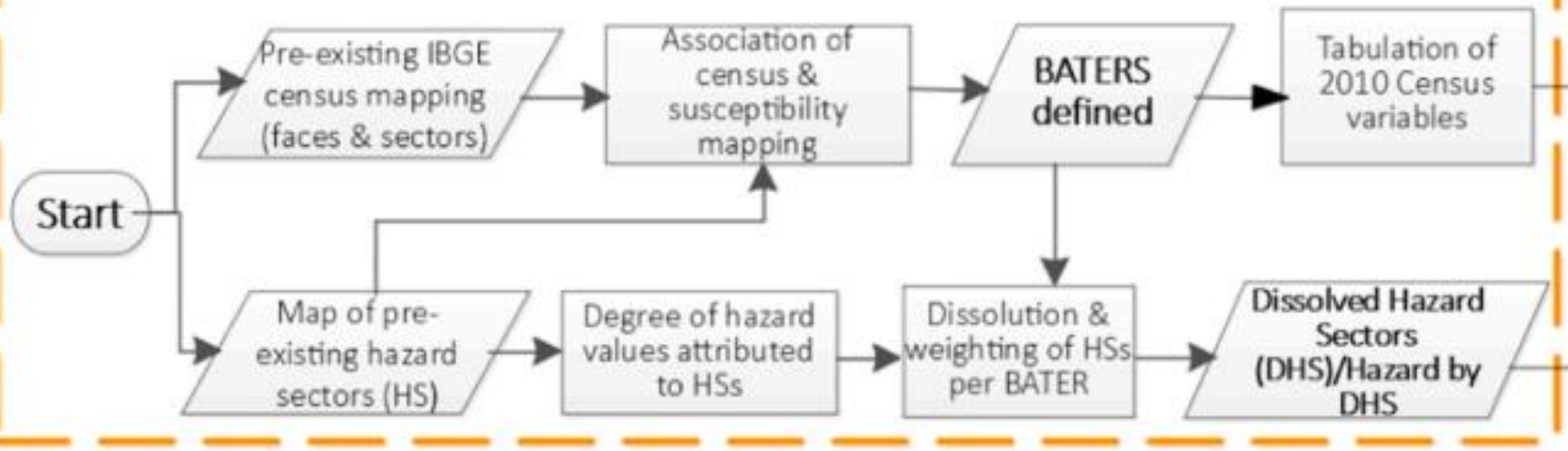
## Compatibilization of hazard sectors and census tracts





# Áreas de Risco

## Compatibilization of hazard sectors and census tracts

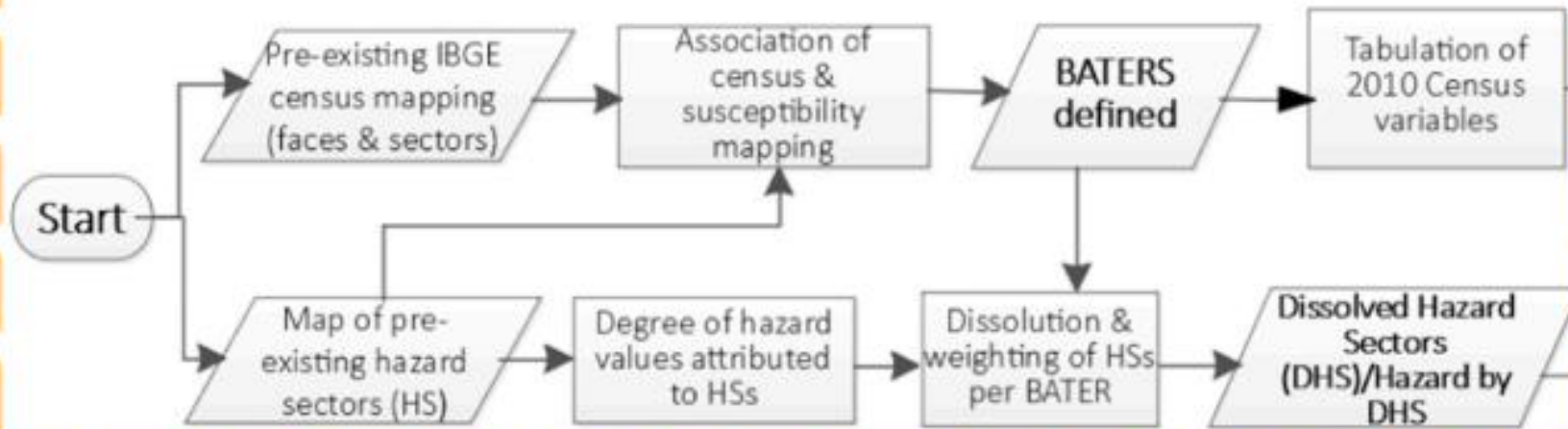


### Rotational slides

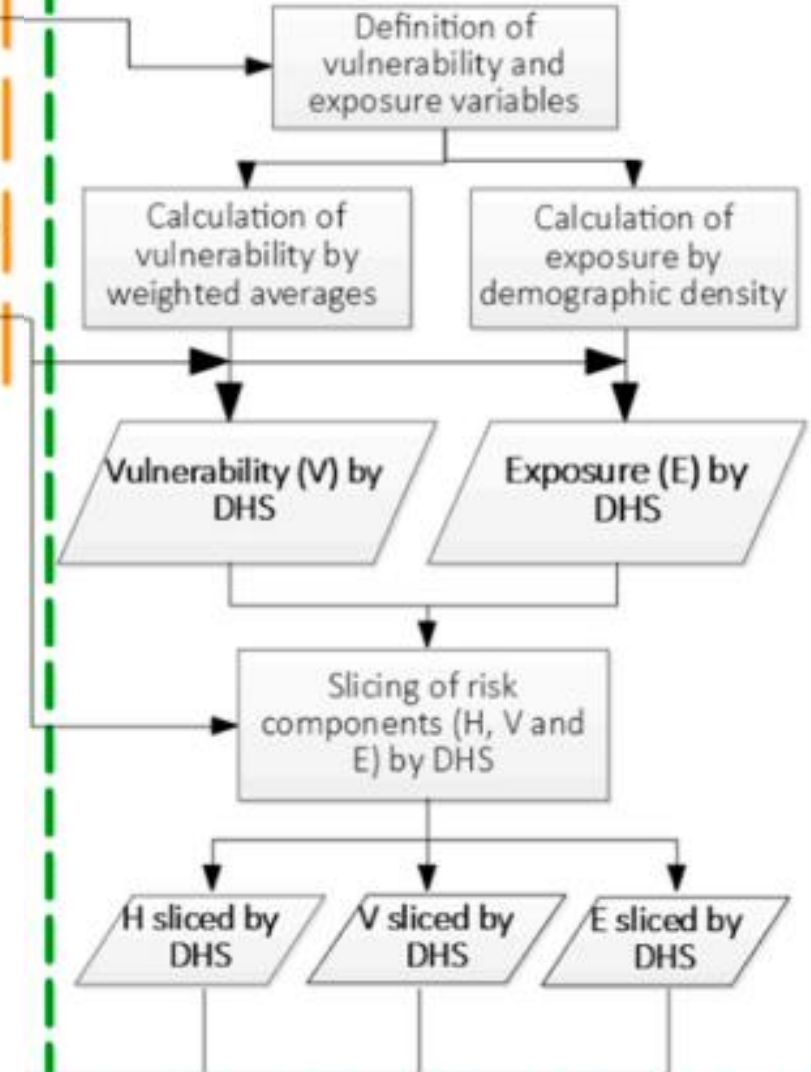


## FASE 2

### Compatibilization of hazard sectors and census tracts



### Calculation and mapping of vulnerability & exposure indicators and slicing risk components



# Exposição




$$\text{Demographic Density by DHS} = \frac{\text{Total residents per DHS}}{\text{DHS area}}$$

$$\text{Normalized exposure} = \frac{V_x - V_{min}}{V_{max} - V_{min}}$$

Level	Normalized Value
Low	0-0.4
Medium	0.40001-0.7
High	0.70001-1.

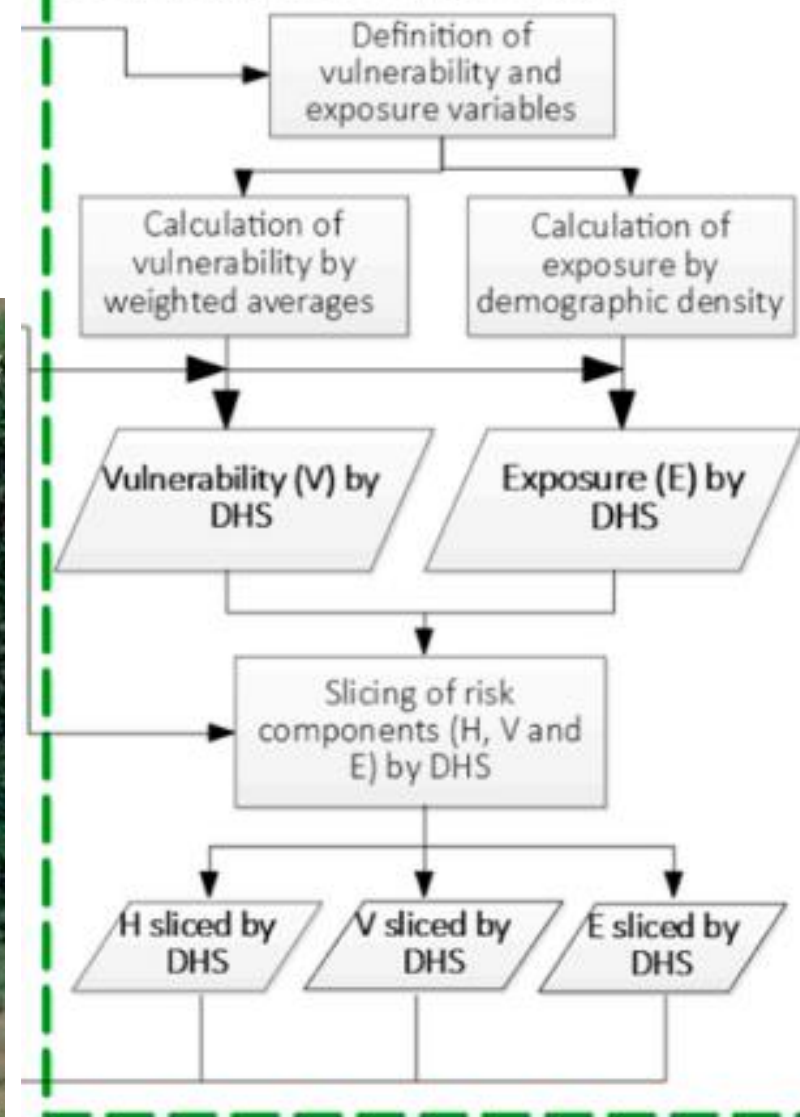


## Components/risk level

	Low
	Medium
	High
	Very High



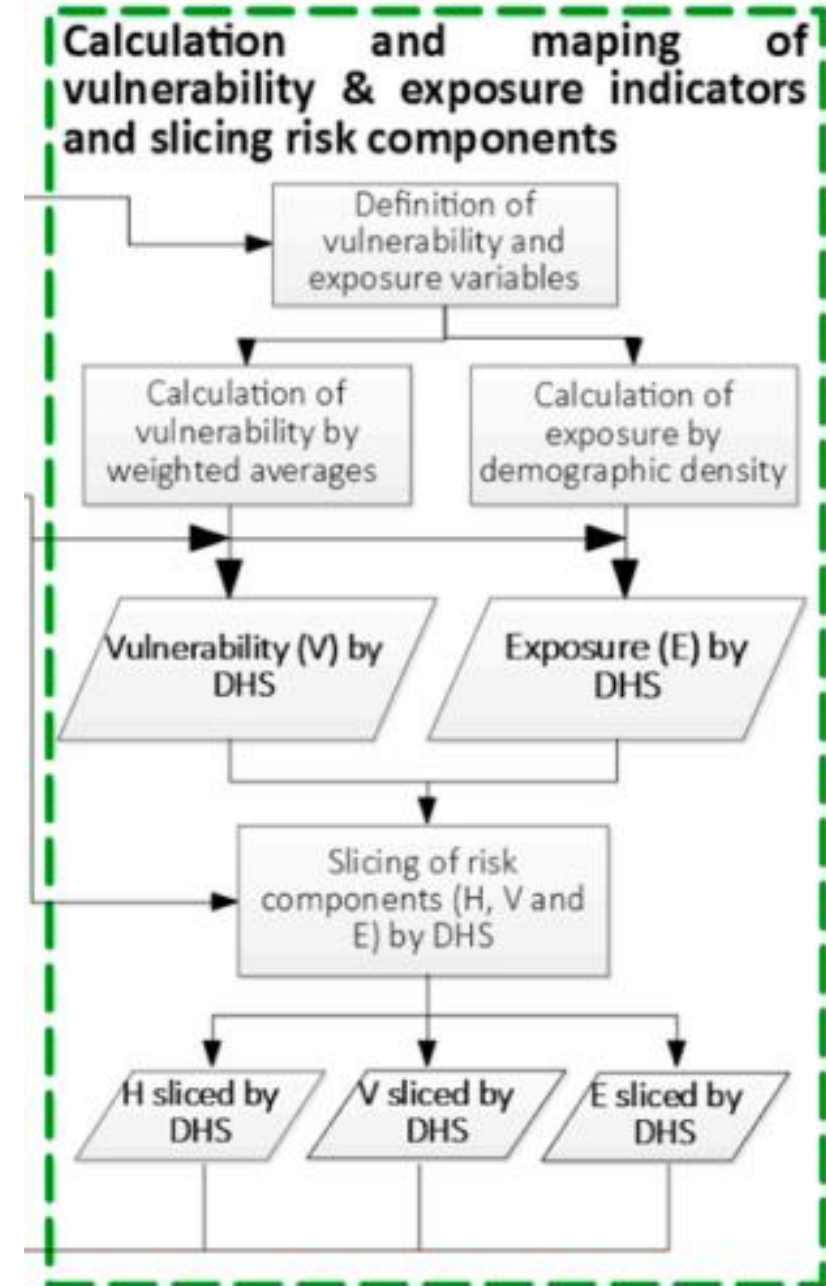
## Calculation and mapping of vulnerability & exposure indicators and slicing risk components



# Vulnerabilidade

Vulnerability dimensions, variables groups and their respective justifications






Vulnerability Dimension	Variables Group	Justification for consideration of variables
<b>Physical</b>	Type of electricity supply	Loss of sewage systems, water and communications constitute infrastructure that may establish an insurmountable financial reconstruction. The lack and precariousness of these infrastructures worsen in disaster and post-disaster situations [16,53,54]. Less infrastructure indicates greater vulnerability.
	Type of water supply	
	Type of sanitary sewage	
	Type of waste collection	
<b>Social</b>	Illiteracy among residents	Poor schooling levels limit the ability to access and understand information. Higher levels of literacy indicate lesser vulnerability.
	Dependence Ratio in relation to age	People of extreme ages are difficult to evacuate in areas with reduced mobility, and parents lose time and money when caring for dependent ages (<14 and >60) contribute to a higher level of vulnerability.
	Type of housing (house, apartment or villa)	The concentration of residences is an important factor in the period immediately post-disaster, as cohabitation provides greater solidarity among residents. Better social cohesion indicates lower vulnerability.
<b>Economic</b>	Type of housing property (own, rented, etc.)	People normally rent properties because they are temporary and, frequently, lack access to information on financial assistance. Residents of rented houses are more vulnerable.
	Residents' income	Greater financial wealth enables an individual to better absorb shocks and access social security networks. The higher the income the lower the vulnerability.



Whilches-Chaux  
(1993)

Cada variável recebeu um peso de 0 a 1 de acordo com Cutter et al. (2003), Bollin & Hidajat (2006), Almeida (2011).

# Vulnerabilidade

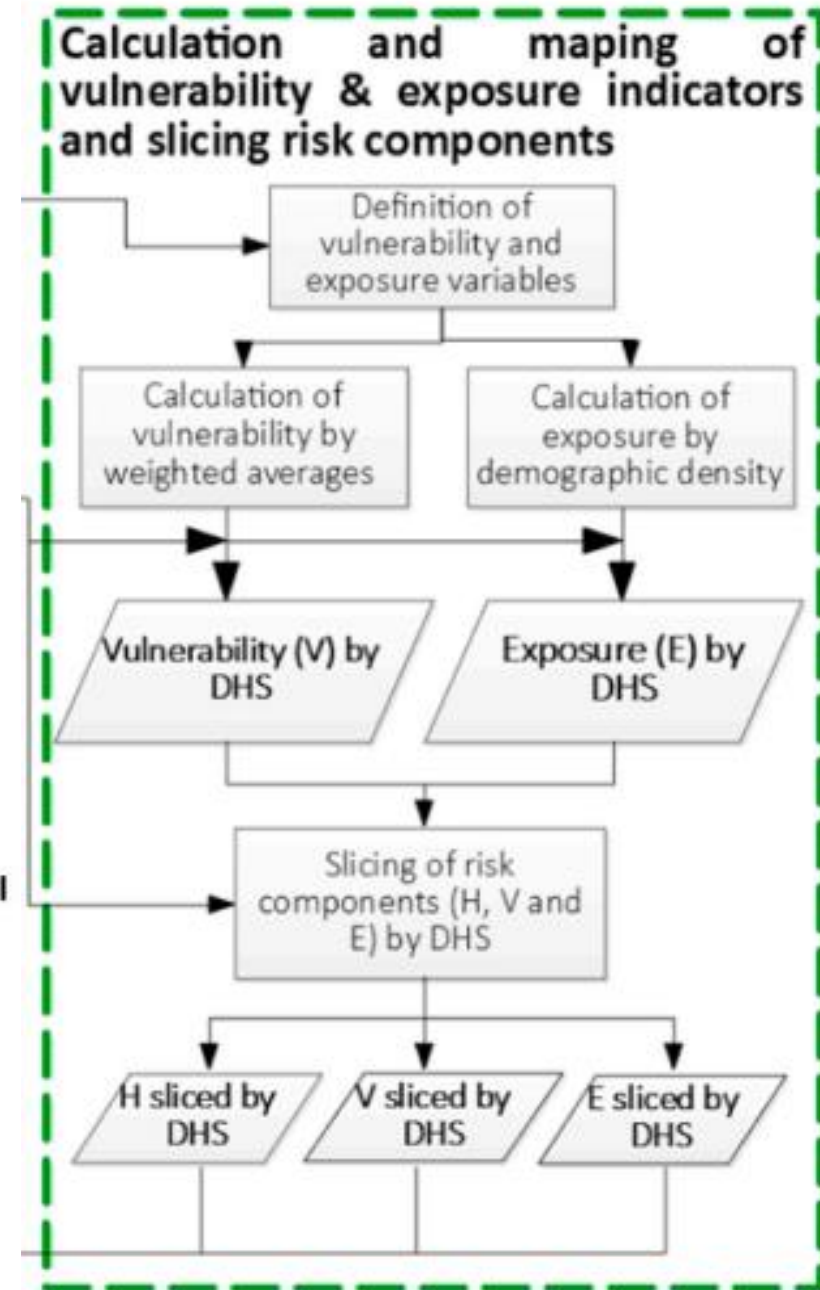
Vulnerability Dimension	Variables Group		
<b>Physical</b>	Type of electricity supply Type of water supply Type of sanitary sewage Type of waste collection	 Infraestrutura	 Vulnerabilidade
<b>Social</b>	Illiteracy among residents  Dependence Ratio in relation to age  Type of housing (house, apartment or villa)	14 > idade > 65  Boa vizinhança	 Vulnerabilidade   Vulnerabilidade
<b>Economic</b>	Type of housing property (own, rented, etc.)  Residents' income	Casa alugada	 Vulnerabilidade

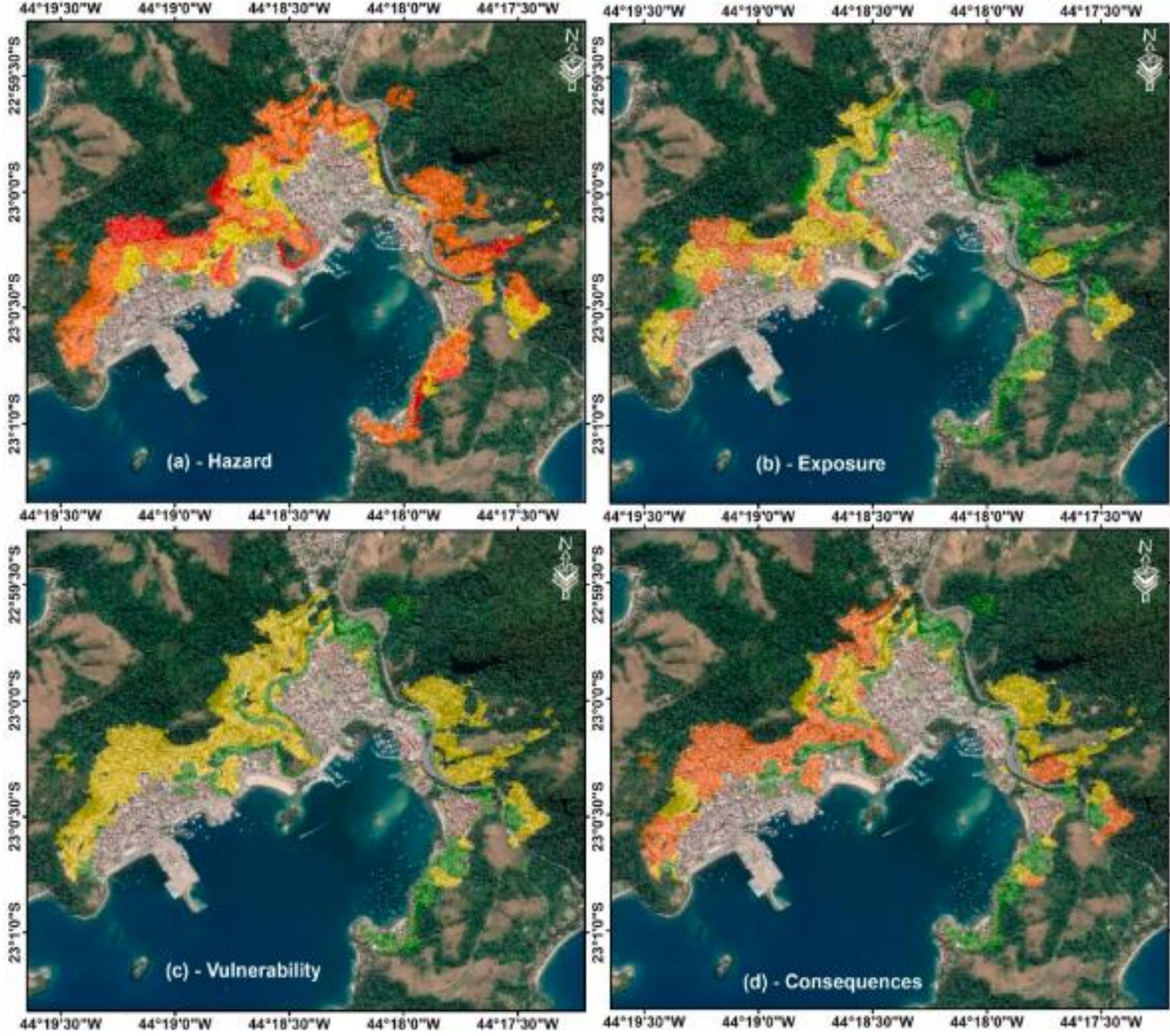
# Vulnerabilidade

Vulnerability Dimension	Variables Group	
<b>Physical</b>	Type of electricity supply	$\text{Variables Group} = \sum_{i=1}^{i=j} \frac{\text{Value of Censo 2010 variable in DHS*score}}{\text{Sum of residences or residents in HS}}$
	Type of water supply	
	Type of sanitary sewage	
	Type of waste collection	
<b>Social</b>	Illiteracy among residents	$\text{Dimension} = \frac{\sum_{i=1}^{i=m} \text{Value of variables group vulnerability}}{\sum_{i=1}^{i=n} \text{groups of variables}}$
	Dependence Ratio in relation to age	
	Type of housing (house, apartment or villa)	
<b>Economic</b>	Type of housing property (own, rented, etc.)	$\text{Vulnerability} = \frac{\sum_{i=1}^{i=p} \text{Value of vulnerability of dimension}}{\text{number of dimensions}}$
	Residents' income	

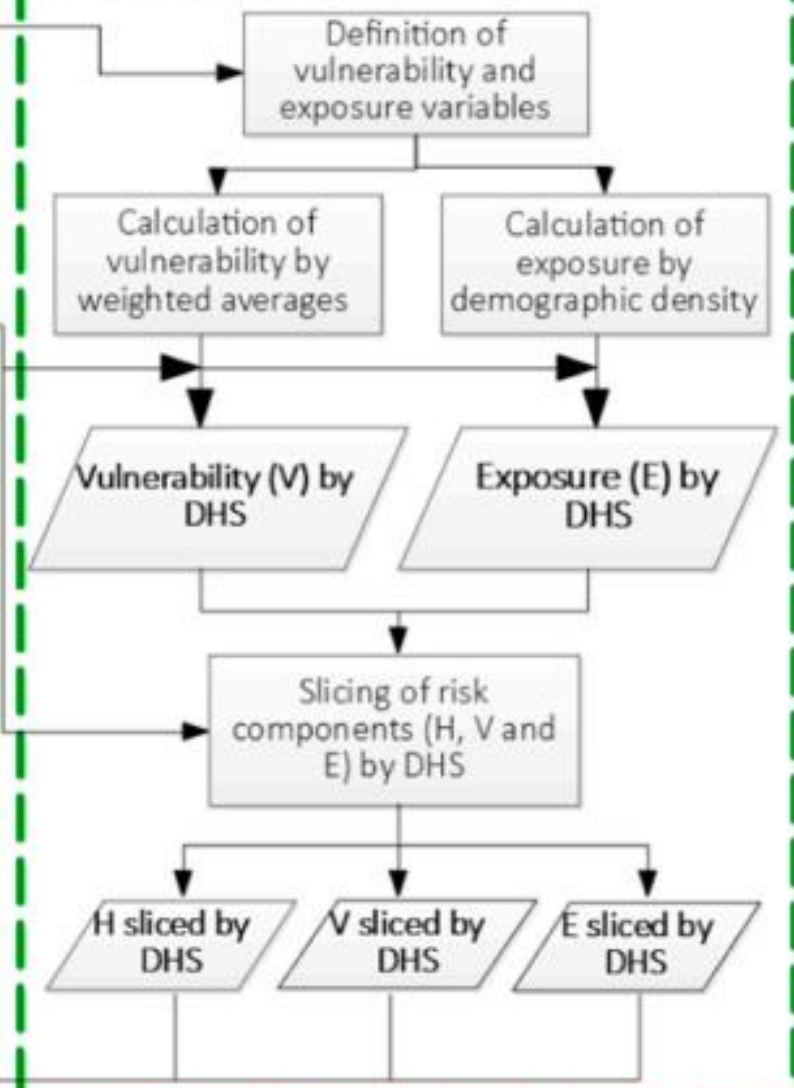
Level	Value
Low	0–0.4
Medium	0.40001–0.7
High	0.70001–1

# Vulnerabilidade





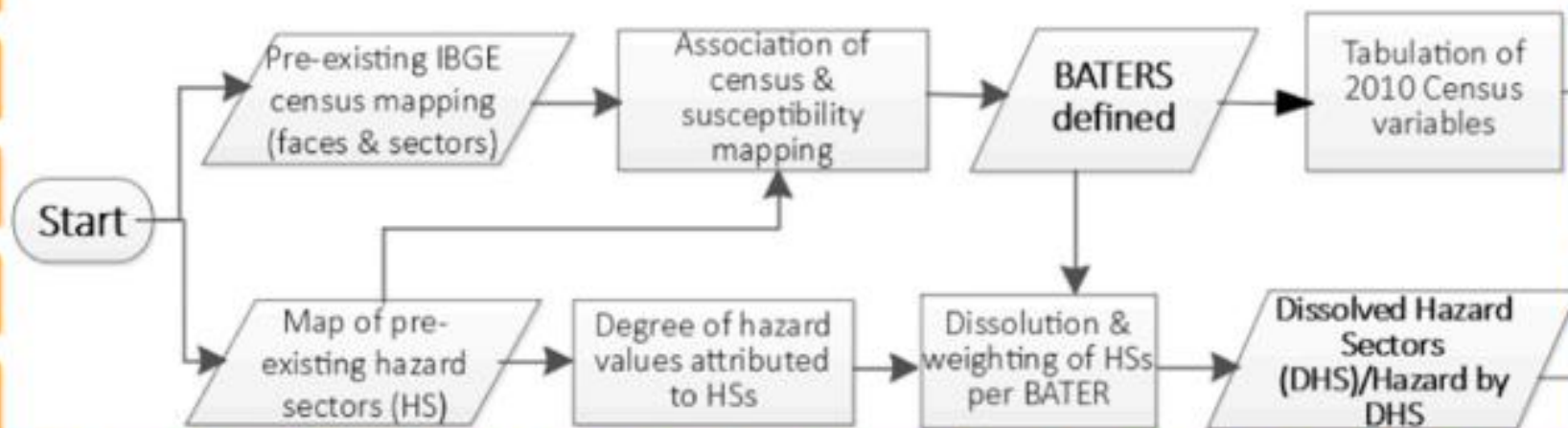
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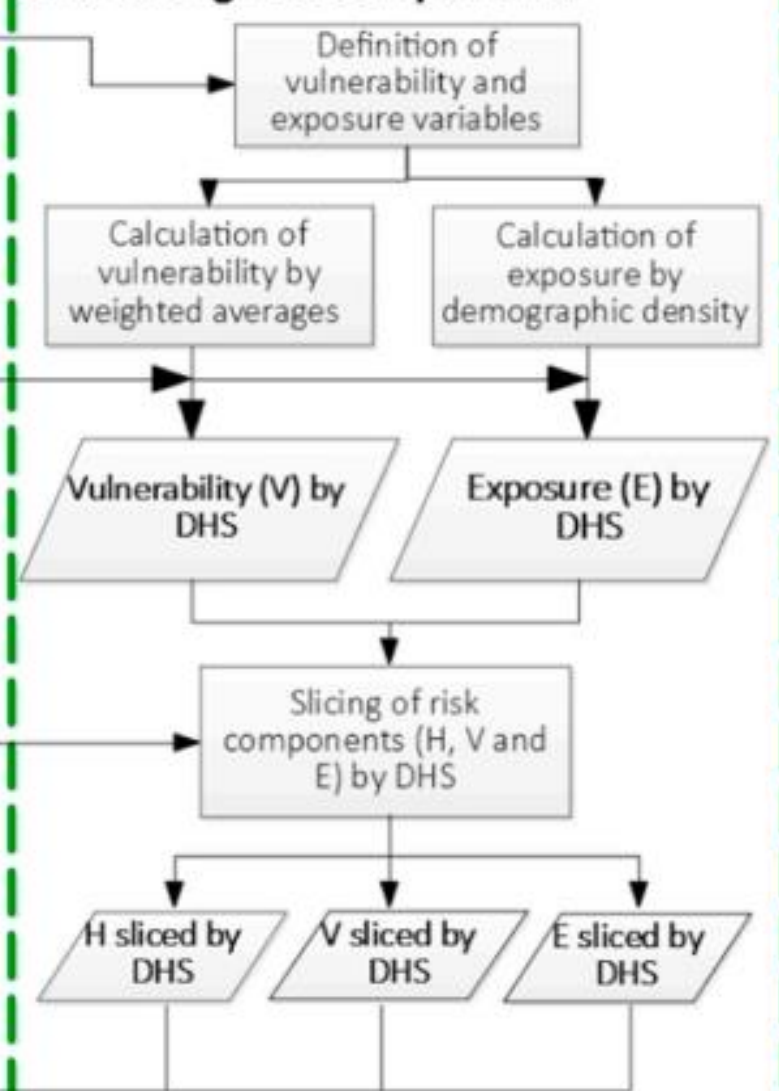


# FASE 3

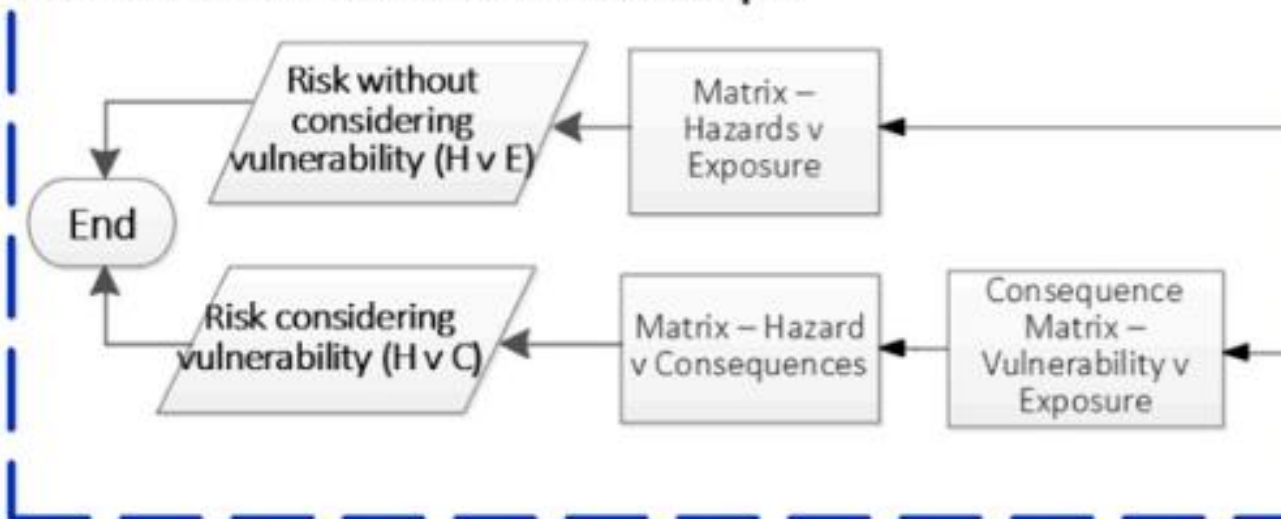
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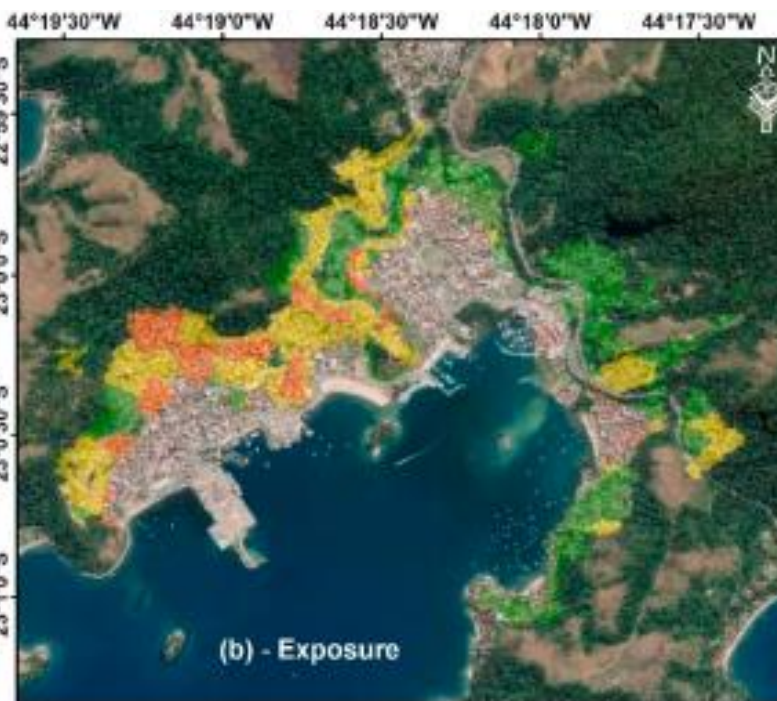
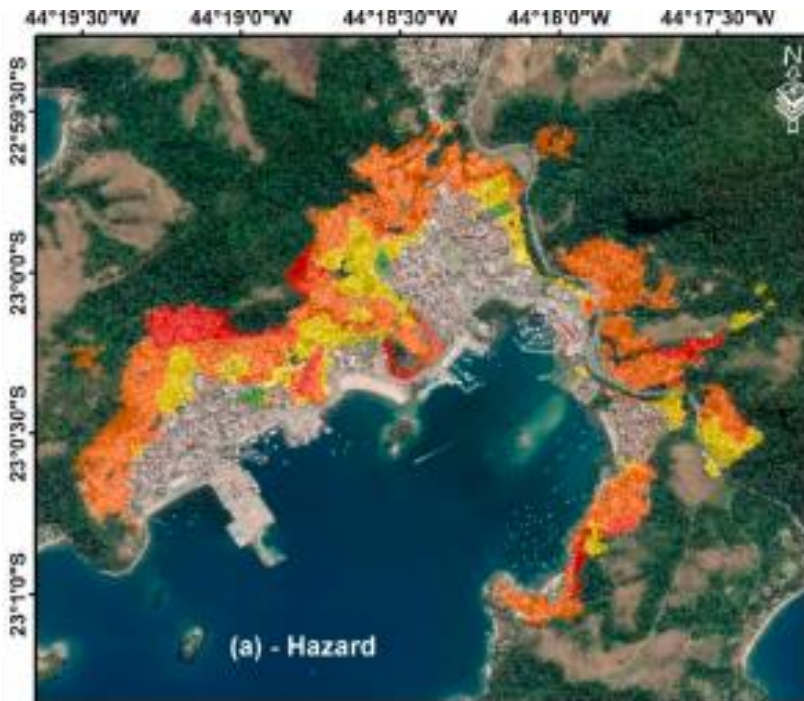


## Calculation and mapping of vulnerability & exposure indicators and slicing risk components

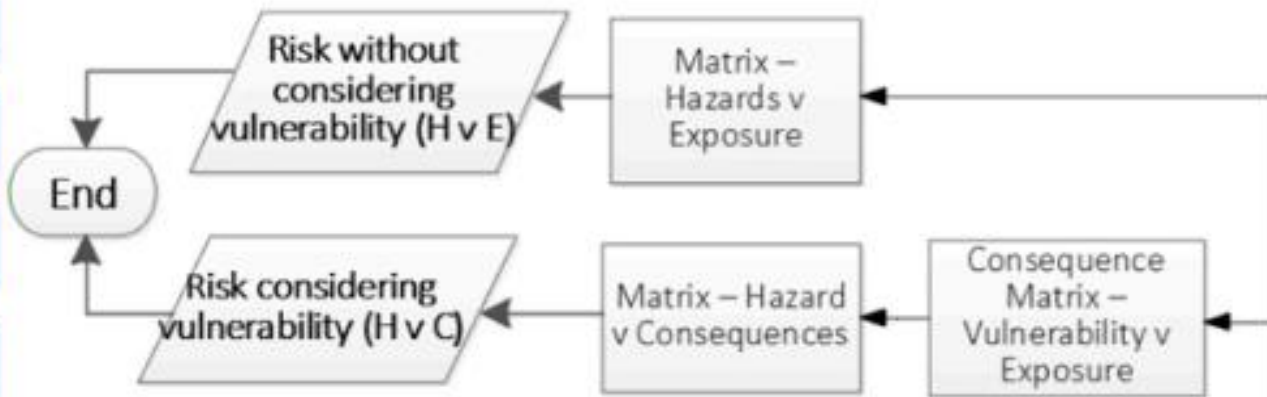


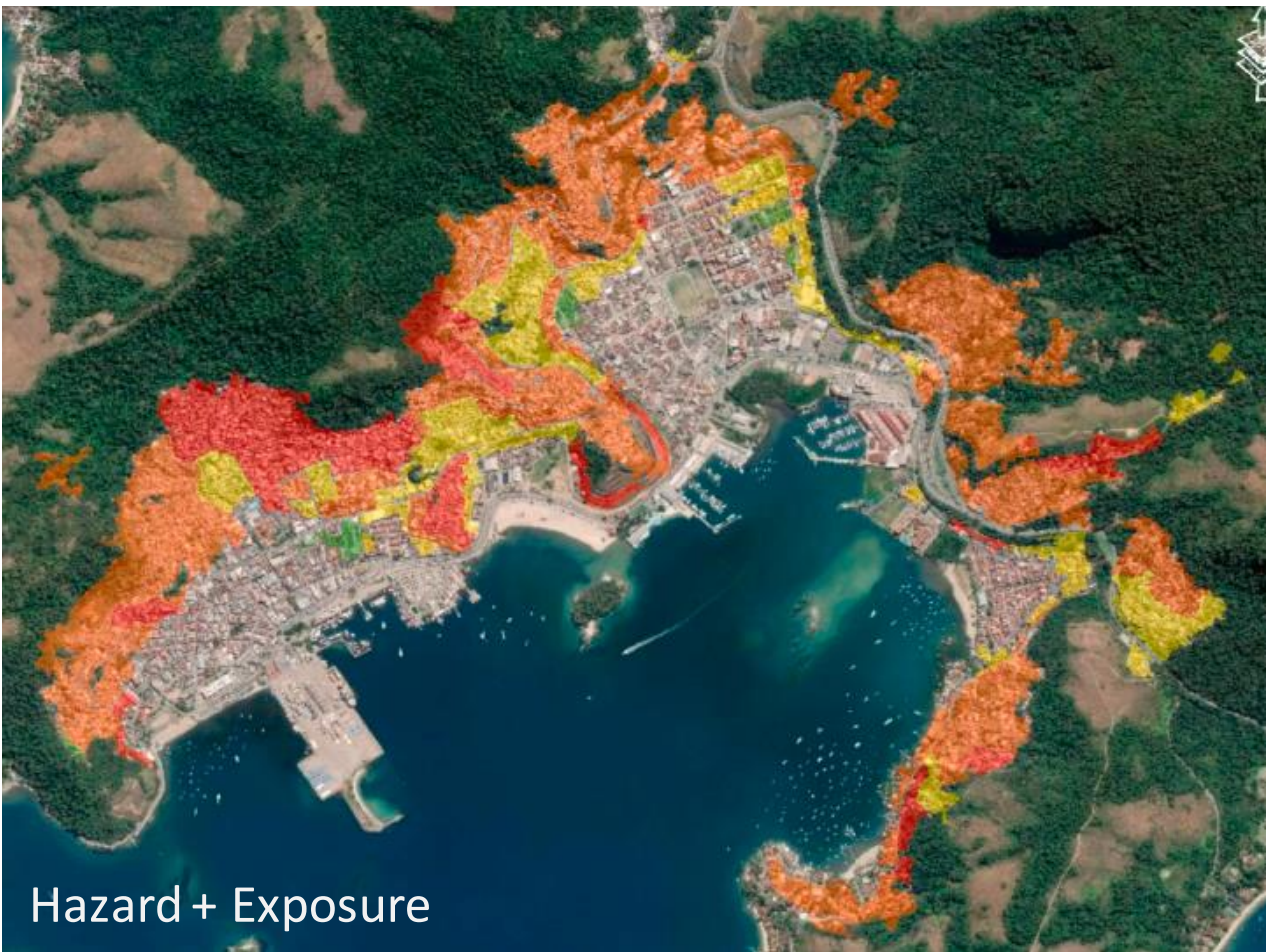
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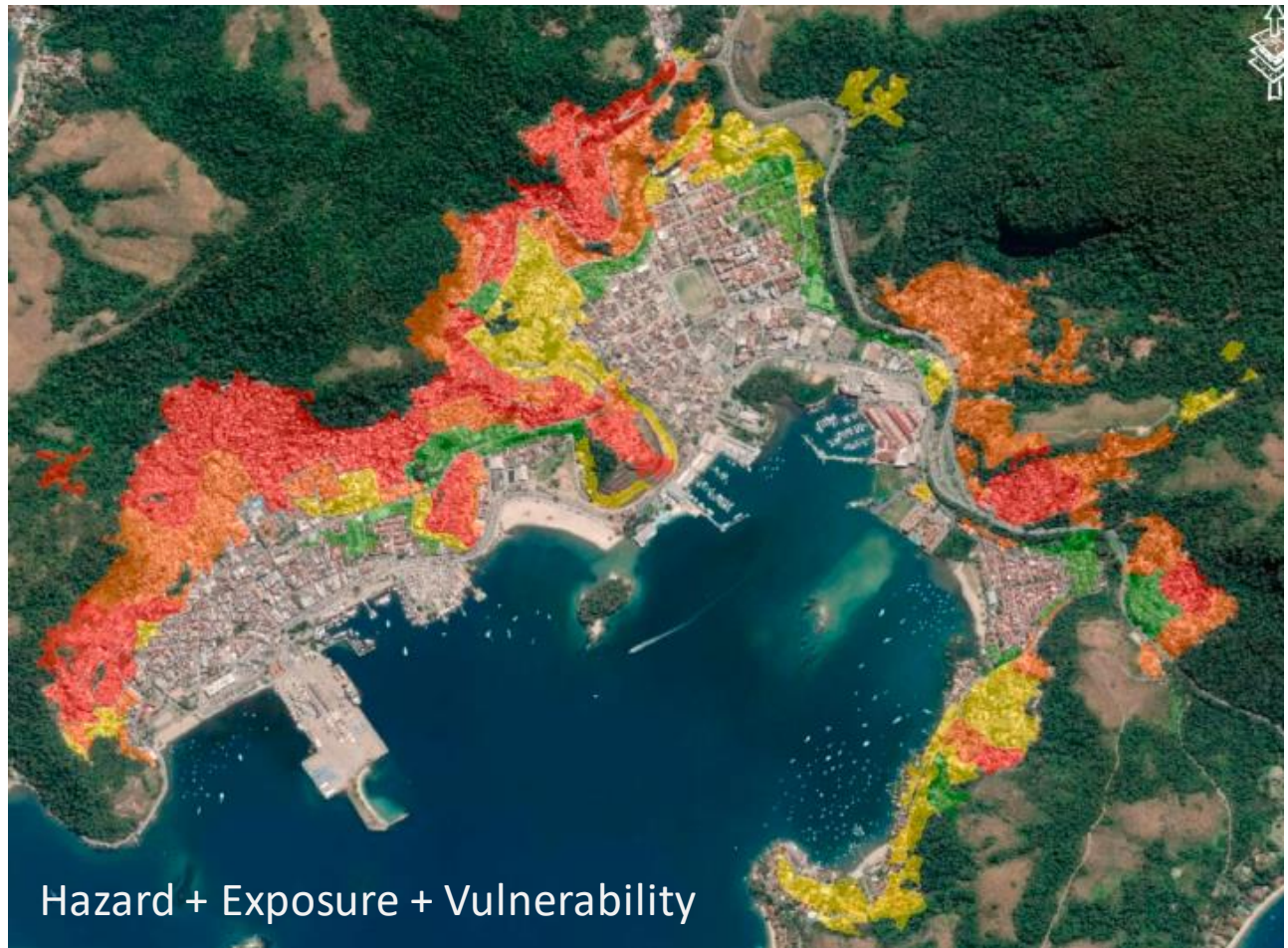


### Formulation of matrices and risk maps





Hazard + Exposure



Hazard + Exposure + Vulnerability

Level of risk	No. of DHS	Area (ha)	% Area	Population	% Population
Low	5	2.99	1.5%	430	1.5%
Medium	32	39.09	19.9%	5546	19.2%
High	51	119.05	60.6%	15,837	54.8%
Very high	23	35.39	18%	7086	24.5%
<b>Total</b>	<b>111</b>	<b>196.53</b>	<b>100</b>	<b>28,899</b>	<b>100</b>

No. of DHS	Area (ha)	% Area	Population	% Population
22	22.44	11.4%	2827	9.8%
28	43.50	22.1%	4142	14.3%
30	63.29	32.2%	7518	26.0%
31	67.28	34.2%	14,412	49.9%
<b>111</b>	<b>196.53</b>	<b>100</b>	<b>28,899</b>	<b>100</b>



decreased 2 levels			decreased 1 level			Level maintained			increased 1 Level		
Qty DHSs	Area (Ha)	Population	Qty DHSs	Area (Ha)	Population	Qty DHSs	Area (Ha)	Population	Qty DHSs	Area (Ha)	Population
3	3.85	172	43	57.11	6,101	38	82.17	12,245	27	53.38	10,381

Quantity of changed DHS = 73 (66%)

Area of changed DHS = 114.35 Ha (58%)

Population in changed DHS = 16,654 (58%)

# Considerações Finais

Resultados compatíveis aos objetivos. 

Estrutura:

- Formato do artigo. 
- Parte representando o todo. 

BATER. 

Discussão final. 

Geral. 



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## Land Use Policy

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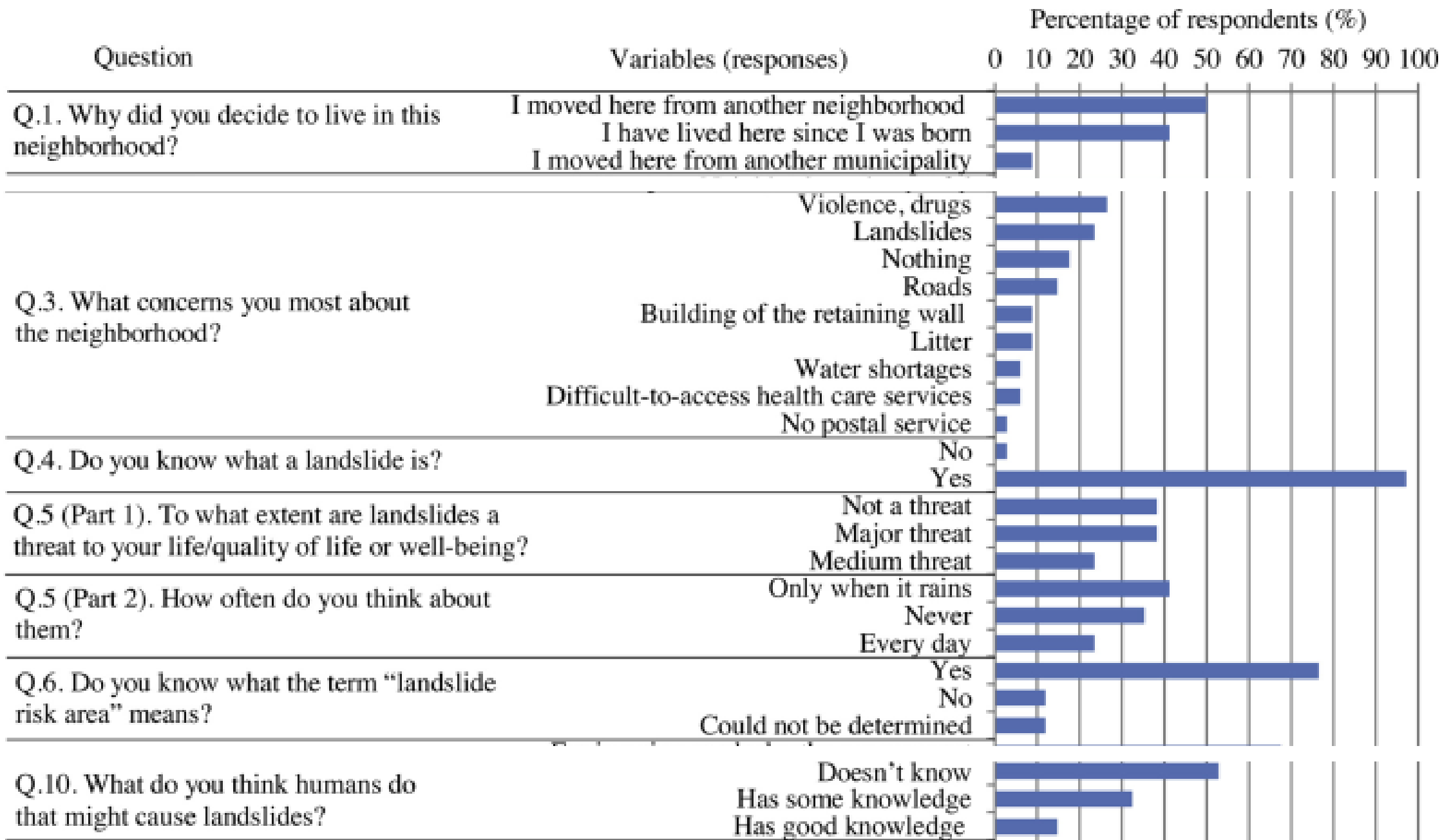
# Landslide risk perception survey in Angra dos Reis (Rio de Janeiro, southeastern Brazil): A contribution to support planning of non structural measures



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*Polytechnic School, Federal University of Rio de Janeiro, Brazil*





<https://encostaviva.poli.ufrj.br/>



"Busca-se contextualizar o conteúdo abordado com a realidade local, fazendo referência às condições das áreas de risco da região."

Tópicos:

- razões sociais dos desastres associados a deslizamentos,
- formas com que os moradores podem contribuir para a redução dos riscos e desastres (RRD).

[Textos retirados do site.]



## Referências

Deslizamento de terra RJ

[https://www.angra.rj.gov.br/noticia.asp?vid\\_noticia=28995&IndexSigla=imp](https://www.angra.rj.gov.br/noticia.asp?vid_noticia=28995&IndexSigla=imp)

<https://anranews.com.br/tragedia-da-carioca-completou-10-anos/>

BATER (*Base Territorial. Estatística de Áreas de Risco*)

<https://www.ibge.gov.br/geociencias/informacoes-ambientais/estudos-ambientais/21538-populacao-em-areas-de-risco-no-brasil.html?=&t=downloads>

<http://marte2.sid.inpe.br/col/sid.inpe.br/marte2/2019/09.13.15.16/doc/97489.pdf>

<https://biblioteca.ibge.gov.br/visualizacao/livros/liv101589.pdf>

<http://www2.cemaden.gov.br/metodologia-inedita-permite-estimar-populacao-exposta-em-areas-de-risco-de-deslizamentos-e-inundacoes-no-pais/>

<http://www.seer.ufu.br/index.php/sociedadennatureza/article/view/46320/27460> (DOI: <http://dx.doi.org/10.14393/SN-v31-2019-46320> )